WNTI Position Paper - Transporting Targeted Alpha Therapies

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world nuclear transport institute

Maintaining transport safety while enabling patient access to emerging cancer treatments

Summary

The 2025 revision of IAEA SSR-6 significantly reduces A_2 activity limits for several radionuclides central to targeted alpha therapy (TAT). WNTI supports the safety objectives underpinning the revision but considers that the practical implications and scientific underpinning for alpha-emitting medical radionuclides warrant urgent, focused international review. The objective should be to maintain an equivalent level of transport safety while avoiding disproportionate barriers to patient access, clinical research and supply chains.

Background

Targeted alpha therapy is a rapidly developing form of nuclear medicine in which short -lived alpha-emitting radionuclides are preferentially bound to cancer cells providing targeted treatment which reduces side effects from irradiating non-cancerous tissue. Its development depends on reliable, time-critical transport of radionuclides and radiopharmaceuticals between production facilities, radiopharmacies and hospitals.

IAEA SSR-6 (Rev. 2), published in December 2025, introduced revised A_1 and A_2 values following reassessment of accident exposure calculations. The revised A_2 values are substantially lower for several TAT radionuclides. A_2 is particularly important because it generally sets the activity limit for non-special-form radioactive material transported in a Type A package.

Scale of change for selected TAT radionuclides

Radionuclide	Previous A_2 (GBq)	2025 A_2 (GBq)	Reduction
Actinium-225	6	0.7	88.3%
Astatine-211	500	4	99.2%
Lead-212	200	0.9	99.55%
Radium-224	20	0.8	96.0%

Why this matters

- **Patient access:** some short-lived radionuclides require sufficient activity at dispatch to compensate for decay in transit. Nuclear Medicine Europe estimated that one average Pb-212 patient-dose would require about 1.2 GBq at dispatch, above the revised A_2 value of 0.9 GBq.
- **Supply-chain resilience:** lower A_2 values can require the use of additional Type A packages, revised distribution arrangements or use of more complex Type B packaging, increasing cost and dependence on limited transport capacity.
- **Geographical equity:** additional packaging or reduced contents and logistics constraints could reduce the distance over which time-sensitive treatments can practically be supplied, creating unequal access between patients and treatment centres.
- **Innovation and investment**: uncertainty over whether future TAT products can be transported economically may inhibit clinical development and scale-up of promising therapies

The Scientific Question

For many radionuclides relevant to TAT, the limiting calculation used to derive the A_2 value is now the $Q_{D,skin}$ accident scenario. The model assumes dispersal of 1% of package contents over one square metre, contamination of unprotected hands, five hours of exposure, and an equivalent skin-dose criterion of 500 mSv.

The source paper identifies specific questions that merit targeted reassessment: the realism of the five-hour contamination period against accident-response and decontamination practice; radioactive decay during exposure for short-lived radionuclides; sensitivity to differing alpha dose-coefficient calculations; and importantly the biological relevance of highly localised superficial alpha irradiation of skin.

These questions do not imply that protection should be reduced. They indicate a need to establish whether the present model introduces disproportionate conservatism for particular medical radionuclides without a corresponding improvement in practical protection. Protection against internal contamination and other relevant exposure pathways must be maintained during any assessment.

WNTI's position

WNTI supports scientifically robust, internationally harmonised transport regulations and the continued use of a graded approach proportionate to radiological risk. The objective should be to preserve the safety outcome of SSR-6 while ensuring that regulatory assumptions remain appropriate for emerging medical applications.

WNTI calls for:

- The IAEA and Member States to establish a dedicated international expert review of the application of revised A_2 values to alpha-emitting medical radionuclides.
- The review to bring together transport regulators, radiation-protection experts, radiopharmaceutical developers, nuclear-medicine stakeholders and transport specialists.
- Focused reassessment of the $Q_{D,skin}$ assumptions and their application to short-lived alpha emitters, including realistic emergency response, decontamination and decay considerations.
- Evaluation of scientifically justified regulatory options to maintain an equivalent level of safety while supporting reliable transport and patient access to treatment.
- Review of the biological relevance of localised superficial alpha irradiation of skin.
- Active monitoring of implementation impacts on clinical trials, manufacturing, package availability, transport capacity and cross-border medical supply chains.

WNTI emphasises this is not a choice between radiation protection and medical innovation. International transport regulation must protect workers, the public and the environment while enabling the safe use of radioactive material for health benefit. A focused, evidence-led review offers a route to maintain confidence in the transport safety framework and avoid unintended barriers to potentially life-saving therapies.

Derek Ray-Hill CEO of the World Nuclear Transport Institute

Annex: Technical background

This annex retains the supporting technical material for readers requiring additional context.

Targeted alpha therapy

TAT uses alpha-emitting radionuclides attached to molecules designed to target cancer cells. Alpha particles deposit substantial energy over very short distances - typically tens of micrometres in biological tissue. Their high linear energy transfer can produce highly localised damage to tumour-cell DNA while potentially limiting irradiation of surrounding healthy tissue. Clinical programmes are investigating alpha-emitting radiopharmaceuticals across a range of difficult-to-treat cancers. Several radionuclides required for development and delivery are affected by the revised A_2 values.

Role of A_1 and A_2 in the transport framework

A_1 and A_2 are fundamental radionuclide values used throughout SSR-6, including in determining the maximum activity permitted in Type A packages. A_1 applies to special-form radioactive material; A_2 generally applies to other radioactive material. The 2025 revision followed reassessment of the IAEA Q-system accident exposure models and, importantly for alpha emitters, included external alpha-radiation dose to skin during cleanup of a hypothetical accident.

Radiopharmaceutical supply chains

Radiopharmaceutical distribution generally has two stages: transport of larger activities from production facilities to processing or radiopharmacy centres, followed by distribution of individual patient doses to hospitals. Both have traditionally relied extensively on Type A packages.

At the production stage, lower limits may require additional packages, changed manufacturing and distribution arrangements, or Type B packages. At patient-dose stage, short half-lives can make delay especially consequential. At-211 has a half-life of approximately seven hours, while Pb-212 is approximately ten hours; additional transit time can therefore require higher dispatch activity to deliver the intended patient activity.

During a presentation by Orano at an IAEA technical meeting in August 2026, it was indicated that the Pb-212 activity administered to the patient could be as high as 300 MBq. At this activity level, the allowable transport time associated with the revised A_2 value would be reduced to approximately 12 hours, which is not operationally feasible.

$Q_{D,skin}$ and areas for scientific assessment

The revised values were calculated using the established Q-system, which considers hypothetical radiation exposure scenarios following a transport accident. For many TAT radionuclides, $Q_{D,skin}$ is now the most restrictive scenario. It assumes 1% of package contents is dispersed over one square metre, contamination of unprotected hands, and five hours of exposure before washing, using an equivalent skin-dose criterion of 500 mSv.

- **Accident-response assumptions**: assess whether five hours before decontamination reflects realistic emergency response, protective equipment and washing practices.

- **Radioactive decay:** account appropriately for decay during the assumed exposure period, particularly for short-lived radionuclides.
- **Dosimetric sensitivity:** examine differences between Monte Carlo calculations at alpha-particle energies around 5–6.5 MeV and the implications of selecting the most conservative coefficients.
- **Biological relevance:** consider the shallow penetration of alpha particles and the depth at which energy is deposited relative to radiosensitive skin layers. The $Q_{D,skin}$ calculations evaluate dose at approximately 50–100 µm depth. Alpha particles will be absorbed almost entirely within this depth for dose evaluation unlike other radiation sources which deposit energy into a much greater volume of skin.
- **Radiological quantities:** equivalent dose, effective dose and absorbed dose are distinct quantities and should not be treated as interchangeable. Protective controls in SSR-6 should be established relevant to the potential radiation harm that is to be avoided. ICRP Publication 118 provides relevant context for skin tissue reactions and biological effectiveness.

A targeted assessment should determine whether the model is appropriately conservative for these specific applications, while preserving protection against internal contamination and all other relevant exposure pathways.

References

[1] IAEA (2025). Regulations for the Safe Transport of Radioactive Material, 2025 Edition. SSR-6 (Rev. 2).
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[3] Nuclear Medicine Europe (2024). Position on the Proposed Revision to IAEA Safety Standard SSR-6.
[4] CORAR (2024). Updated A_1/A_2 Position Paper, 23 September 2024.
[5] ICRP (2012). ICRP Statement on Tissue Reactions. ICRP Publication 118, Annals of the ICRP, 41(1–2).